RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)

Submitted by: TC 7.5 Smart Building Systems

Title: Demand Response Optimization Protocol and Integrated Training

Research Category: Operation and Maintenance Tools

Research Classification: ?

TC/TG Priority: #?

TC/TG Vote: ?-?-? (Chair not voting)

Estimated Cost: $120,000

Other Interested TC/TGs: Possible TC 7.4, Building Operation Dynamics, and 7.3, Operations and Maintenance Management, to co-sponsor this RTAR?

Possible Co-funding Organizations: California Energy Commission, Southern California Edison, Wisconsin Focus on Energy

Handbook Chapters to be Affected By Results of this Project:

The results of this project may be appropriate for inclusion in Chapter 38 *Operation and Maintenance Management* of the HVAC Applications Handbook, or as a standard

State-of-the-Art (Background):

The importance of a stable and reliable electric power grid to life and the economy in the 21st century has been underscored by two major events over the last decade: a major black out on the east coast of North America and wildly varying electricity prices in California during an attempt at restructuring the electricity marketplace. In response to these events many organization (DOE, EPRI, and CEC) have started research activities to find ways to modernize the grid and make the entire network more reliable through operations practices and technology adoption. However, there are significant barriers to widespread adoption and integration of demand control strategies and energy efficient technologies especially as they relate to buildings. Since buildings consume over 70% of the electric in the U.S., they have to be part of the solution to modernize and make the entire the grid more reliable. ASHRAE has traditionally developed technologies, standards, and guidelines for building design and operation.

In a 2001 order addressing the California crisis, the Commission stated: Without a demand response mechanism, the [independent system operator] is forced to work under the assumption that all customers have an inelastic demand for energy and will pay any price for power. There is ample evidence that this is not true. Many customers, given the right tools, can and will manage their demand. There have been many ASHRAE-sponsored and other independent projects that have researched the development strategies for building operators to use in managing building electric demands. However, a key finding of a 2003 test report indicated that "…… new knowledge is needed to procure and operate technology and strategies for DR. DR is a complex concept. Facility operators need to understand DR economics, controls, communications, energy measurement techniques, and the relation between changes in operation and electric demand. "

Advancement to the State-of-the-Art:

Utilities are increasingly developing new rate "products" designed to manage the electric grid. Two primary categories of demand response are incentive-based demand response and time-based rates. Each category includes several major options:

- Incentive-based demand response
    - Direct load control
    - Interruptible/curtailable rates
    - Demand bidding/buyback programs
    - Emergency demand response programs
    - Capacity market programs
    - Ancillary-services market programs
- Time-based rates
    - Time-of-use
    - Critical-peak pricing
    - Real-time pricing

The increasing complexity in the world of utility rate structures has the potential to both confuse and frustrate the marketplace. And although there are a large number of studies that individually address different methods to control demand and integrate demand response signals from utilities into a commercial building energy systems, very little has been done to establish a protocol that can be easily understood and used by building operators to establish the demand control potential for their facility. And little has been done to train building operators how to implement a complete package of demand side management strategies that would unlock the full demand response potential for their facility. And, finally, little work has been done to determine the true cost effectiveness and measurement reduction potential for individual buildings on a large-scale.

This research, to be carried out in three phases, will address the development of a standard protocol that will allow a building operator to establish an integrated resource plan for their specific facility that addresses energy efficiency, demand control and demand response. The end results of the plan will be the identification of least cost options to provide space conditioning, lighting, and power while meeting occupant comfort and building use objectives. And, the research will detail methods to determine the cost effectiveness and measurement reduction for individual buildings that implement their plans.

Justification and Value to ASHRAE:

This research directly addresses the concept of sustainability, which is the underlying theme of the ASHRAE Strategic Research Plan. A report by FERC indicated that developing better demand response forecasting tools for system operators was needed to increase the usefulness and acceptability to demand response. Central to increasing the comfort level of system operators to become more accepting of demand response are removal of the key barriers:

- Lack of understanding how buildings respond and,
- Measurement of demand response

This research also addresses two of the topic areas listed in the ASHRAE Strategic Plan under the Research Opportunity Theme “Energy and Resources”, namely, to develop peak load management: operations, design, and controls methods and determine the cost of energy resources: buildings, systems, transportation, power generation and distribution

Data from national sources indicates that the commercial sector contributes approximately 330,000 MW of demand to the U.S. electric system during peak periods. That demand represents roughly 40% of the generating capacity. Studies have shown that savings on the order of 10% are achievable if buildings are set up and controlled in a manner to tap their demand reduction potential.

Objectives:

The research necessary to develop demand response optimization protocol is envisioned to be carried out in three phases

The objectives of Phase 1 are to establish the criteria for the protocol design including the target market segment, key training parameters, and methods to assess the success of the design protocol and associated training. Phase 1 will continue by then seeking out and documenting the existing tools and strategies that have been developed that can be used to meet the criteria. Phase 2 objectives will include the development of the protocol and training module(s). And finally, Phase 3, will beta test the protocol with actual building owners/operators. Phase 3 activities will include the validation of implemented demand control and response measures.

References:

U.S. Department of Energy, Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them: A Report to the United States Congress Pursuant to Section 1252 of the Energy Policy Act of 2005, February 2006 (February 2006 DOE EPAct Report), 6.

Demand Shifting With Thermal Mass in Large Commercial Buildings: Field Tests, Simulations and Audits Xu, P., P. Haves and M.A. Piette (Lawrence Berkeley National Laboratory) and L. Zagreus (University of California at Berkeley). LBNL-58815. January 2006.

Evaluating the Performance of Building Thermal Mass Control Strategies
Braun, J.E., K.W. Montgomery, and N. Chaturvedi, International Journal of Heating, Ventilating, Air-Conditioning and Refrigeration Research, Vol. 7, No. 4, pp. 403-428, 2001.

Findings from the 2004 Fully Automated Demand Response Tests in Large Facilities, M. A. Piette, D. S. Watson, N. Motegi, and N. Bourassa, Lawrence Berkeley National Laboratory, September, 2005

Advanced Controls and Communications for Demand Response and Energy Efficiency in Commercial Buildings
S. Kiliccote, M. A. Piette Lawrence Berkeley National Laboratory and David Hansen U.S. Department of Energy
LBNL-59337 Presented at *Second Carnegie Mellon Conference in Electric Power Systems:* Monitoring, Sensing, Software and Its Valuation for the Changing Electric Power Industry, January 12, 2006, Pittsburgh, PA. Lawrence Berkeley National Laboratory